First Chemical Separations of Seaborgium (Element 106)

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The first chemical separations of seaborgium (Sg, element 106) have been performed in both the aqueous- and gas-phase.

Experiments to determine the chemical properties of lawrencium (Lr, element 103), rutherfordium (Rf, element 105), and hahnium (Ha, element 105) have clearly shown that the actinide series ends with Lr, and that Rf and Ha are the first two members of the 6d series of transition metals, with Lr³⁺, Rf⁴⁺, and Ha⁵⁺ being the most stable oxidation states. While the most general chemical properties of Rf and Ha indicate that they are members of the fourth and fifth groups of the periodic table, respectively, we have found that the detailed chemical properties of these first transactinide elements cannot be reliably extrapolated from the chemical properties of their lighter homologs. These deviations from the periodicity of the elements have been explained as being due to relativistic effects in the electronic orbitals. In this light, it is of great interest to investigate the the chemical properties of Sg, and compare its chemical properties to the lighter periodic table homologs, W and Mo.

Recently, ^{265}Sg (E $_{\alpha}\text{=}8.8$ MeV, $t_{1/2}\text{-}8$ s) and ^{266}Sg (E $_{\alpha}\text{=}8.6$ MeV, $t_{1/2}\text{-}13$ s) have been identified in $^{22}\text{Ne} + ^{248}\text{Cm}$ bombardments. 1 The half-lives are long enough to allow chemical separation with the most modern techniques, and the production rates are sufficient for detection of about 1 atom per day (after chamical separation).

In the chemical experients, ²⁶⁶Sg and ²⁶⁵Sg were produced in ²²Ne bombardments of ²⁴⁸Cm targets at the GSI UNILAC. Products were transported to the chemical separation apparatus via an aerosol-loaded gas-jet.

Gas-phase chemical separations² were performed with the OLGA III gas-phase

isothermal chromatography apparatus. Volatile oxychlorides of Sg were formed, and their retention time in a quartz column was measured as a function of the temperature of the column. We found Sg oxychlorides to be somewhat less volatile than oxychlorides of Mo and W formed under the same conditions.

Aqueous-phase chemical separations were carried out with the ARCA apparatus, a miniaturized, computer-controlled, liquid column chromatography apparatus. $^{265}\,\mathrm{Sg}$ was eluted from cation exchange-resin (Aminex A6) columns with 0.1 M HNO3 /5x10-4 M HF. Under these conditions, the $^{261}\,\mathrm{Rf}$ and $^{257}\,\mathrm{No}$ α -decay products of $^{265}\,\mathrm{Sg}$ are strongly retained on the columns. Observation of the decays of $^{265}\,\mathrm{Sg}$ daughter activities, $^{261}\,\mathrm{Rf}$ and $^{257}\,\mathrm{No}$, after the columns indicates that Sg forms neutral or anionic complexes (presumably $\mathrm{SgO_4}^{2\text{-}}$). This behavior is similar to measured properties of the periodic table homologs, W^{6+} and Mo^{6+} , and unlike that of U^{6+} .

Footnotes and References

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